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Indian Standard

GUIDELINES FOR TESTS AND TRIALS OF SHIPBOARD AIR-CONDITIONING SYSTEMS

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GUIDELINES FOR TESTS AND TRIALS OF SHIPBOARD AIR-CONDITIONING SYSTEMS

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Indian Standard

GUIDELINES FOR TESTS AND TRIALS OF SHIPBOARD AIR-CONDITIONING SYSTEMS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 January 1981, after the draft finalized by Shipbuilding Sectional Committee had been approved by the Marine, Cargo Movement and Packaging Division Council.

0.2 It is necessary to test the air-conditioning system after installation on board ship. The primary object of testing is to ascertain that the specified amount of air is being distributed in all the spaces to accomplish the design objectives. The adjusting of the system to achieve this is known as ' balancing the system '.

0.3 It is not possible to test a marine air-conditioning plant at the commissioning stage because the design indoor conditions cannot be achieved unless design ambient conditions and various heat transfer coefficients are created.

It will be more relevant to replace the temperature check up at the time of commissioning by the early approval of the method and basis of calculation or air quantity and to test the air flow only to each space. With correct air flows, it would be reasonable to assume that the plant would maintain design indoor conditions, provided the installed machinery and cooling coil will have the required capacity.

0.4 This standard is one of the series of Indian Standards on marine air-conditioning. The other standards in the series are as follows:

IS : 8434-1977 Air-conditioning requirements on board ships

IS : 8649 (Part I)-1977 Procedure for designing the air-conditioning system on board ships: Part I Heat load calculations

IS : 9114-1979 General requirements for insulation in air-conditioned spaces on board ships

SECTION I AIR SYSTEM TRIAL

1. SCOPE

1.1 This standard (Section I) covers the procedure for air system trial of the marine air-conditioning plant.

2. AIR SYSTEM TRIAL PROCEDURE

2.1 Shop Testing of Components

2.1.1 If type testing of following components has previously been done by an independent recognized organization, a certified copy of the performance particulars only need to be furnished and only routine tests shall be carried out:

a) Fan including fan motor and starter, and

b) Chilled water circulation and salt water circulation pump.

2.2 Installation Checks

2.2.1 *Visual Inspection* — Ensure that trunking, fans, filters and terminals are clean and free from debris accumulated during installation. Clean out holes and access plates are correctly fitted as required for quick and thorough cleaning of the trunks and fittings.

2.2.2 *Anti-vibration Mountings* — Correct type of anti-vibration mountings are used and properly installed.

2.2.3 *Supply and Exhaust Terminals* — All external watertight covers, supply and exhaust terminals are fully open, recirculation flaps are correctly positioned and that doors, hatches, side scuttles, etc, are closed as appropriate to normal operations.

2.2.4 *Filters* — The filters are to be checked for external damage and correct installation in comparison with air direction.

2.2.5 *Fan Impellers and Motors* — Ensure that fan impellers revolve in correct direction and the motor is operating at full speed.

2.3 Instrumentation — Instruments are needed to measure the following parameters with an acceptable accuracy:

a) Air velocity, and

b) Air temperature and humidity.

2.3.1 *Air Velocity Instruments*

a) *Velometer* — a velocity meter that gives a direct reading of air speed and pressure. It is a convenient instrument for shipboard use provided the instrument is carefully maintained and overhauled at regular intervals. Tolerance of reading should not be more than 3 percent of true reading.

b) *Vane annemometer* — an air velocity meter of recording type over a period of time. With this meter the air velocity (m/sec) can be obtained. It is suitable for m/c space ventilation recording.

2.3.2 *Air Temperature and Humidity Instruments*

a) *Mercury-in-glass thermometer* — measures room temperature at steady state.

b) *Globe thermometer* — measures the mean radiation of surrounding structure and equipment.

c) *Sling psychrometer* — indicates the dry bulb (DB) and wet bulb (WB) temperatures of the surrounding air. For obtaining correct reading, a relative motion of the meter or air to be made available.

d) *Hygrometer* — gives a direct reading of humidity of the air.

2.4 Air Quantity Trial

2.4.1 Ensure that the fans are rotating at correct direction and rpm.

2.4.2 The total air circulating in the system shall be measured at all outlet terminals and shall be recorded in the record sheet as given in Appendix A, from which the total quantity/unit can be determined. The recorded air quantity for compartments shall be checked with the designed air quantity and if needed, the dampers in the trunking shall be adjusted for achieving the designed air changes. Thus the complete air system shall be balanced. The recorded air quantity per room shall be within ± 10 percent of the design requirement. In this way the total air quantity per Air Handling Unit shall be determined.

2.4.3 The dry and wet bulb temperatures of the inlet and outlet air of the Air Handling Unit shall be recorded over a period of time and average value of the heat removal shall be obtained. From the above, the total heat handled by each unit shall be determined and shall be compared with the design selection.

SECTION II MACHINERY TRIAL

3. SCOPE

3.1 This standard (Section II) covers the trial of machinery with its associated refrigerant, cooling water and control equipment of the marine air-conditioning plant.

4. PROCEDURE FOR MACHINERY TRIAL

4.1 Installation Checks

4.1.1 *Visual Inspection* — The following shall be checked during visual inspection:

a) The installation is complete in accordance with drawings and specifications;
b) Equipments are undamaged;
c) Duct and necessary refrigerant pipe insulation is complete;
d) Instrumentation is complete, properly cited and calibrated; and
e) Adequacy of accessibility for operation and maintenance.

4.1.2 *Anti-vibration Mountings and Securing Arrangement* — Anti-vibration mountings and securing arrangement for various equipment are complete as per drawings.

4.2 Instrumentation

4.2.1 *Gauges and Thermometers* — Pressure, compound and oil pressure gauge for compressors, compound gauge for cooling coil outlet and pressure and compound gauge for cooling water pumps are the minimum essential requirement of refrigeration system. The thermometers housed in gunmetal casing and pockets shall be used for the following:

a) Condenser cooling water inlet and outlet;
b) Compressor discharge and suction;
c) Cooling coil, refrigerant inlet and outlet;
d) Cooling water pump discharge and suction;
e) Chilled water pump discharge and suction pipe;
f) Heat exchanger inlet and outlet; and
g) Steam temperature and pressure at preheating coil inlet and outlet.

For chilled water system, where fitted.

4.2.2 *Safety Controls* — The following safety controls are essential:

a) Low pressure safety control for compressor suction;
b) High pressure safety control for compressor discharge;
c) Oil pressure safety control for compressor lubricating oil system;
d) Pressure relief valve for condenser, receiver and compressor (if fitted);
e) Electrical interlocking of fan, pump and compressor; and
f) Hydraulic interlocking of cooling water pump or line pressure of cooling water system with compressor through water pressure switch/flow switch.

4.2.3 *Auto Controls* — The following electrical auto controls are generally used:

a) Return air thermostat for operating liquid line solenoid;

b) Pressostat for operating solenoid valve;

c) Supply air thermostat or direct acting proportional steam regulating valve for operating reheat coil; and

d) Proportionate control thermostats for motorised valve for damper unit for chilled water system.

4.3 Pressure Testing the Refrigeration System — After the installation of refrigeration circuit, the system shall be pressure tested with dry nitrogen or carbon dioxide gas. The testing pressures shall be as follows:

For Freon 12	14 kg/cm²
For Freon 22	17·5 kg/cm²

4.3.1 The pressure shall stand for 24 hours without any drop. The drop in pressure indicates leak in the system. Leaks shall be repaired till the pressure holds good for 24 hours. After the pressure test the gas shall be released. On completion of the pressure test, the compressor shall be charged with lubricating oil to the correct level.

4.3.2 The water system shall be subjected to hydraulic pressure testing in accordance with IS : 7304 (Part I)-1978*.

4.3.3 If steam heating is fitted, pipe testing shall conform to the requirements of statutory authorities or classification societies.

4.4 Evacuating the System — The rotary type of vacuum pump shall be used for vacuumising the system. The system shall be evacuated to $-2{\cdot}1$ kg/cm². The vacuum shall stand for a period of minimum 12 hours.

4.5 Charging the System — The vacuum shall be broken by refrigerant only. During charging, the full amount of charge shall be determined by condensing/evaporative temperatures/pressures and liquid line sight glass. The topping up of the system shall be made after stabilization of the system.

4.6 Balancing the System

4.6.1 *Superheat Setting* — After stabilization of the system the superheat in the cooling coil shall be set to 7°C, if required.

4.6.2 *Setting of Controls* — All the safety and auto controls used in the system shall be set to the designed cut in and cut out points for particular refrigerant.

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*Code for fabrication, installation and testing of salt water piping system for shipboard use: Part I General requirements.

4.6.3 *Balancing* — The balancing of the system shall be done in accordance with IS : 4881-1968*.

4.7 Endurance Test

4.7.1 Before endurance test the following preparatory servicing shall be carried out:

- a) Lubricating oil in the system shall be replenished only if the same is dirty and correct level shall be maintained;
- b) All the strainer in the refrigeration system shall be cleaned;
- c) Oil strainers shall be cleaned;
- d) Dessicant in the filter drier shall be replenished, if needed; and
- e) Leak detection shall be done with halide leak detectors or other suitable method.

4.7.2 *Chilled Water and Heating System*

- a) *Chilled water system* — Before trials are started the chilled water systems shall be inspected and pressure tested as given in **4.3.2** to ensure the following:
  - 1) The systems are fully charged and all air vented;
  - 2) Piping run, pipe size, valves, strainers, venturimeter and flow control fittings are fitted in accordance with the drawings;
  - 3) Pump is operating satisfactorily;
  - 4) Thermostatic valves are set to give full flow through coolers; and
  - 5) Ensure proper make up feed from open expansion tank or closed pressure feed expansion tank, ensure air separation from the enlarged tee, by providing a water sight glass in the expansion tank line.
- b) *Heating systems* — Performance test of heating system shall be carried out under prevailing ambient condition.

4.7.3 The Basin endurance trial shall be of not less than 48 hours. During the trials, the operation of the automatic controls shall be observed and the working conditions of the machines adjusted to test the proper functioning.

4.7.4 All the test and trial data shall be recorded as given in Tables 1 to 4.

---

*Code for practice for design of shipboard mechanical ventilation trunking.

TABLE 1 CAPACITY TRIAL

(*Clause* 4.7.4)

SHIP DATE AMBIENT DB: WB:

Capacity Trial

Air Handling Units	Cooling Supply		Coil Mixed		Refrigeration Capacity Designed	Recorded	
	DB	WB	DB	WB	$\frac{m^3/hr \times kg/m^3 \times kcal/kg}{3 \times 10^3} = TR$		
1.							
2.							
3.							
4.							
5.							

QUANTITY & PERCENTAGE OF FRESH AIR

Average velocity of air at fresh air intake grill = 1. m/sec

2.

3.

4 .

5.

1. Grill opening area = m^2

Net opening area = m^2

2.

3.

4.

5.

Quantity = Net Area × average velocity = m^3/hr

	Designed	*Recorded*
1.		
2.		
3.		
4.		
5.		

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TABLE 2 HABITABILITY TRIALS

(*Clause* 4.7.4)

Ship **Date** **Sea/River** **Weather**

Time	10·00		12·00		14·00		16·00		18·00		21·00		24·00		03·00		06·00		08·00		No. of Person	Average Effective Temperature (E. T.)
Temperature in °C	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB	DB	WB		
Ambient																						
Mean Compartment Temp																						
1.																						
2.																						
3.																						
4.																						
5.																						
6.																						
7.																						
8.																						
9.																						
10.																						
11.																						
12.																						
13.																						
14.																						
15.																						
16.																						
17.																						
18.																						
19.																						
20.																						
Return air temp																						

TABLE 3 MACHINERY TRIAL

(*Clause* 4.7.4)

DATE TIME	10·00	12·00	13·00	14·00	15·00	16·00	17·00	18·00	20·00	22·00	01·00	04·00	06·00	07·00	08·00	09·00	REMARKS
1. Machinery compartment temperature																	
2. Compressor delivery pressure																	
3. Compressor delivery temperature																	
4. Condensor liquid temperature																	
5. Compressor suction pressure																	
6. Compressor suction temperature																	
7. Oil pressure																	
8. Condensor water inlet temp																	
9. Condensor water outlet temp																	
10. S. W. pump delivery pressure																	
11. S. W. pump suction pressure																	
12. Compressor rpm																	
13. Compressor motor rpm																	
14. S. W. pump motor rpm																	
15. Compressor motor current																	
16. S. W. pump motor current																	
17. Supply volts																	
18. Supply frequency																	
19. Chilled water inlet temp																	
20. Chilled water outlet temp																	
21. Chilled water flow																	
22. Sea water flow																	
23. Chilled water pump suction pressure																	
24. Chilled water pump delivery pressure																	
25. Expansion tank pressure																	
26. Steam temp and pressure at preheating coil inlet and outlet																	
27. Ambient temperature																	
28. Ambient relative humidity																	
29. Chilled water pump motor voltage and current																	

TABLE 4 MACHINERY TRIAL

(*Clause* 4.7.4)

Date:

PROTECTIVE/SAFETY DEVICES

	DESIGNED	RECORDED
1. High pressure cutout		
2. High pressure differential		
3. Low pressure cutout		
4. Low pressure differential		
5. Oil failure cutout		
6. Time for above cutout		
7. Compressor unloading		
8. Interlocking electrical		
9. Return air thermostat cutout		
10. Return air thermostat cutin		

CALIBRATION OF ELECTRICAL OVERLOAD ON STARTER

Amps

1. Air handling unit motor
   a) ....
   b) ....
   c) ....
   d) ....
   e) ....
2. Compressor motor
   a) ....
   b) ....
   c) ....
   d) ....
   e) ....
3. S. W. pump motor
   a) ....
   b) ....
4. Chilled water pump motor
   a) ....
   b) ....

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APPENDIX A

(*Clause* 2.4.2)

AIR QUANTITY TRIAL

No.	Fan			Motor						Compartment		No. and Size of Diffuser	Area	No. and Size of	Area	Average Velocity m/s	Total Air Quantitiy		m^3/h
	Size and Type	Maker's No.	Maker's Name and HP	Rated			Recorded			Name	Deck						Designed	Recorded	
				volts	amps	rpm	volts	amps	rpm				m^2	PL					